

## **California Regional PM<sub>10</sub> and PM<sub>2.5</sub> Air Quality Study (CRPAQS)**

### **Statement of Work – CRPAQS Data Analysis Task 1.1c**

#### **COMPARISON AND DESCRIPTIVE EVALUATION OF THE AIRBORNE AND GROUND BASED MEASUREMENTS COLLECTED DURING THE CCOS FIELD EXPERIMENT**

**STI-902323-2303-WP  
Sonoma Technology, Inc.**

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#### **Introduction**

As a part of the overall Task 1.1 effort, STI will compare and evaluate the airborne and ground-based measurements collected during the Central California Ozone Study (CCOS) field experiment. The success of any data analysis or modeling project that incorporates both the airborne and surface measurements depends to a large extent on the comparability of these observations. While STI already has the California Air Resources Board (ARB) performance audits for each of the CCOS sites/platforms, these audit data were collected under necessarily controlled and non-ambient conditions. Direct intercomparisons between the measurements of identical species in ambient air is possible by carefully selecting time periods wherein two systems should have been sampling the same air mass. This includes the wing-tip flight intercomparisons between the various aircraft involved in CCOS as well as the low altitude passes near surface sites made by several aircraft throughout CCOS. Careful examination of these data may reveal any systematic biases for one or another platform. Having knowledge of any potential biases may be very useful during subsequent interpretation of the data.

The questions to be addressed in this part of Task 1.1 of the RFP are as follows:

- What is the comparability and equivalence among collocated sampling methods?
- What are the biases of one instrument with respect to others?
- How can these biases be minimized?

In addition to the utility of aircraft data in understanding the chemistry and dynamics that influence the surface observations, comparison of the surface and aloft measurements will be useful for understanding how well hourly (or 5-minute average in the case of CRPAQS) surface data or hourly model input data or outputs can be expected to compare with high-frequency aloft data. These comparisons also help researchers understand to what extent the surface data collected represent the mixed layer above. Finally, the data collected on the aircraft platforms can be used effectively as a transfer standard to assess comparability of measurements for several ground sites on a given day.

## Current Knowledge

STI has been involved with a number of aircraft-based studies in the San Joaquin Valley (SJV); most recently, STI operated two aircraft and conducted a total of 38 sampling missions in the SJV and upwind regions for the CCOS study conducted from July through September 2000 (Buhr et al., 2001). Utilizing the data collected during these sampling missions as a transfer standard will serve to establish the level of consistency between different surface-based sites, enhancing the overall utility of the CRPAQS data set.

Findings from previous comparisons include the following:

- Roberts and Main (1989) compared surface and aircraft ozone, nitrogen oxides ( $\text{NO}_x$ ), and light scattering ( $b_{\text{scat}}$ ) data collected in the SJV during 1988. For ozone measured by aircraft at the lowest altitude of the aircraft spiral over the surface site (typically 70 to 120 m msl), the two measurements compared within  $\pm 10$  ppb. The largest differences between the concentrations were observed in the early morning and late evening sampling periods. In these cases, the aircraft measured a higher concentration (by about 20 ppb) than the surface monitor. Temperature profile data and vertical pollutant profiles indicated that the nocturnal boundary layer (NBL) had set in, resulting in a region of steeply increasing ozone concentration within the NBL. In this study, the aircraft  $b_{\text{scat}}$  data were compared to particle scatter measurements made at the surface using LIDAR.
- Blumenthal et al. (1997) compared aircraft and surface ozone and  $\text{NO}_x$  data collected during the SJVAQS/AUSPEX in 1990. On average, the lowest 25-m aircraft ozone averages were about  $14 \pm 20$  ppb higher than the surface hourly averages, day or night. Aircraft  $\text{NO}_2$  (measured as total reactive nitrogen ( $\text{NO}_y$ ) – nitric oxide ( $\text{NO}$ )) 25-m averages were about  $3 \pm 13$  ppb lower than the surface hourly averages at night but only  $1 \pm 5$  ppb lower in the daytime.

This project provides researchers with two new unique opportunities for air quality study in the SJV: (1) comparison of surface and aircraft ozone and  $\text{NO}/\text{NO}_y$  data collected at less than 1-hr intervals (i.e., 1- to 5-minute averages), and (2) comparison of surface and aircraft nephelometer  $b_{\text{sp}}$  values.

## Overview of Technical Approach - Data Availability and Site Selection

The common set of observations between the two STI aircraft and the core ground sites (Bakersfield, Fresno, Angiola) include ozone,  $\text{NO}$ ,  $\text{NO}_y$ , light scattering, temperature, relative humidity (RH), and winds. We propose to focus our comparisons on measurements of these pollutants with an emphasis on the nephelometer data ( $b_{\text{sp}}$ ).

We will select spirals that came within 100 m of the surface and within 10 km of a surface air monitoring site (Blumenthal et al., 1997). We will average the pollutant data from the bottom 25 m of each spiral and compare these averages to the corresponding 5-minute (or 10-minute or 1-hr) averages from the nearby surface station.

Potential matches of aircraft spirals and surface data include surface sites near Bakersfield, Angiola, several sites in and around Fresno, Altamont, Bethel Island, and Modesto. In all cases, comparisons will be made between the measurements collected aboard the aircraft and the available, comparable measurements made at the surface sites. Since both of the STI aircraft platforms will be used as sources of data we will also present the results of the wing-tip to wing-tip comparison performed with those aircraft as part of the CCOS experiment. An example of a flight plan used during CCOS is shown in **Figure 1**. This figure shows the relationship between the CCOS flight paths and the surface measurement sites.

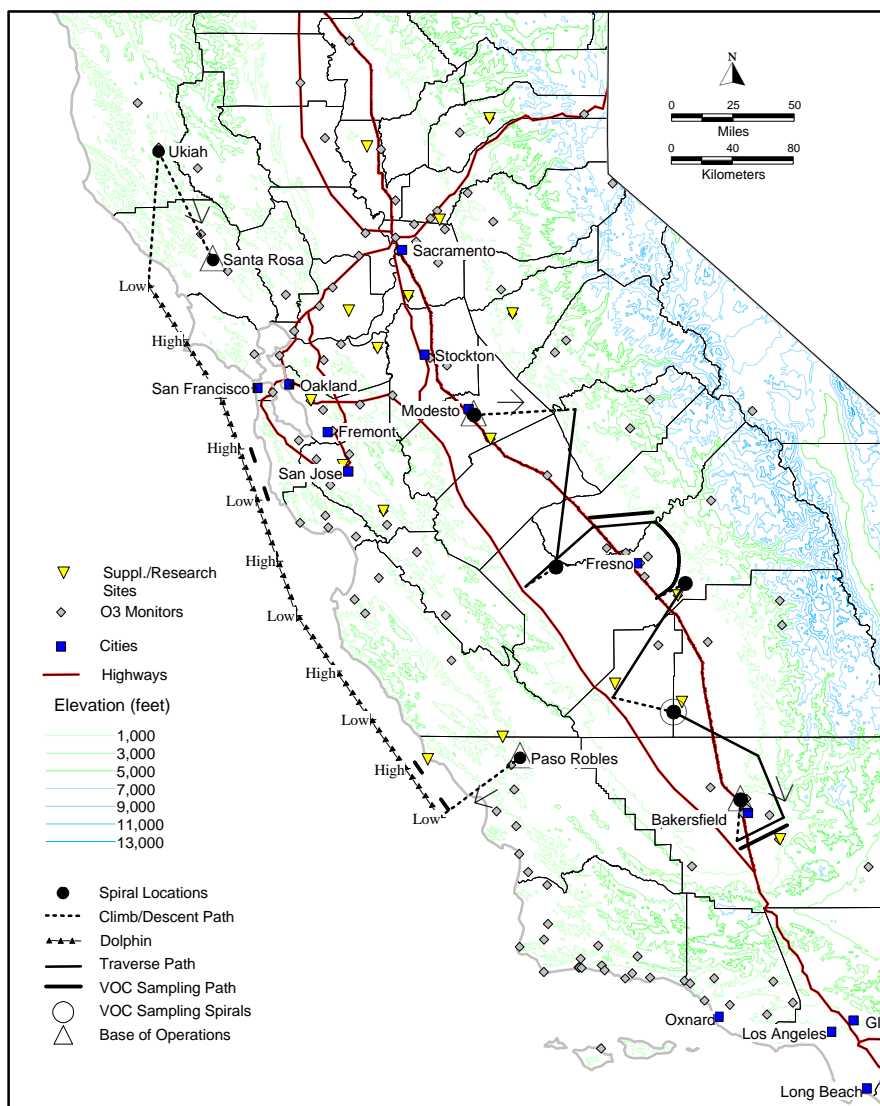


Figure 1. Afternoon flight routes executed by the STI Aztec (endpoint at Santa Rosa) and Cessna (endpoint at Bakersfield) at the start of an intensive operating period during CCOS. These flight routes were designed to characterize the flux of ozone and ozone precursors into and through the study domain (Aztec on the Western Boundary [A2 flight route] and Cessna in the southern end of the SJV [C2 flight route]). Other flight routes were performed during the CCOS project depending on the forecasted conditions.

Once we have selected the sites, dates, and times of corresponding samples, we will obtain the necessary data from the CRPAQS (surface) and CCOS (aircraft) data management systems. Prior to data analysis, we will review the documentation accompanying the data to best understand any existing quality issues including time periods with missing or invalid data. We assume that the desired measurements will be available from the CRPAQS data management system in common formats.

## **Scope of Work**

The individual tasks for Task 1.1c include:

- Task 1. Compile a database of the periods containing ground and aircraft measurements of reasonable coincidence in space and time.
- Task 2. Examine the comparison of measurements collected with respect to the vertical and horizontal gradients observed. The vertical gradient can be derived from the aircraft data when a vertical profile was collected over the ground site, and the horizontal gradient can be assessed by examining the ground-based record for some period before and after the overflight.
- Task 3. Make a quantitative assessment of the comparability of the ground- and aircraft-based measurements. Assess the comparability between measurement sites based on individual comparisons to the aircraft data.
- Task 4. Prepare a technical memorandum containing the results of these specific analyses.

## **Time Line**

STI shall complete tasks 1 through 3 before June 6, 2003. A draft technical memorandum will be delivered to the ARB at that time. Any necessary revisions to the draft technical memorandum after review by ARB will be completed within four weeks after receipt of comments.

## **Schedule of Deliverables**

Deliverable	Deliverable Due Date
Draft technical memorandum	June 6, 2003
Final technical memorandum	Four weeks after ARB comments on draft
Manuscript for publication/presentation	Fall 2003

## **Description of Deliverables**

The technical memorandum will include a discussion of the data included in the airborne-to-surface data comparison, data plots showing the comparisons, a discussion of the conditions

attendant to the comparison periods, and an assessment of the comparability between measurement sites based on individual comparisons to the aircraft data.

### **ARB Staff Assigned to this Task**

The ARB Project Manager assigned to this Task is:

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### **STI Staff Assigned to This Task**

The STI Project Manager is Lyle R. Chinkin. The STI Task Manager assigned to this task is Martin P. Buhr.

### **Percentage of Work, Data Products to be Performed/Delivered by ARB**

None.

### **Software and Models to be Used by STI**

The following software will be used for this task:

- IGOR Pro version 4 (Wavemetrics, Inc.) will be used for data analysis and manipulation.
- Microsoft Word will be used in preparing documentation.

### **Models, Reports, or Other Data to be Supplied to STI by ARB**

STI will primarily use the CCAQS database for all intercomparisons and evaluations.

### **References**

Blumenthal D.L., Lurmann F.W., Kumar N., Dye T.S., Ray S.E., Korc M.E., Londergan R., and Moore G. (1997a) Assessment of transport and mixing and OTAG model performance for Northeast U.S. ozone episodes. Summary of results. Report prepared for Ozone

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